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Education, Preferences, and Household Welfare

Marcel Fafchamps — University of Oxford*

Forhad Shilpi — The World Bank

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Abstract

Using census data from Nepal, we examine how the marginal effects of male and female education on various household welfare indicators vary with education levels. Parental education is associated with better household outcomes, but marginal effects vary with education level. Higher child survival, for instance, is associated higher primary education for mothers and higher secondary education for fathers. We calculate conditional marginal effects that correct for assortative matching of spouses and compare them to unconditional estimates. The two differ because mother and father education are partial substitutes. We also show that the marginal effects of education have fallen over time while education levels were rising. Using the relative scarcity of women in the marriage market as proxy for the weight of female preferences in household choices, we find that educated mothers prefer better educated children, but also prefer their children to work, possibly because they are more likely to work themselves.

*Department of Economics, University of Oxford, Manor Road, Oxford OX1 3UQ. Email: marcel.fafchamps@economics.ox.ac.uk. Fax: +44(0)1865-281447. Tel: +44(0)1865-281446.

Centre for the Study of African Economies
Department of Economics · University of Oxford · Manor Road Building · Oxford OX1 3UQ
T: +44 (0)1865 271084 · F: +44 (0)1865 281447 · E: csae.enquiries@economics.ox.ac.uk · W: www.csae.ox.ac.uk

1. Introduction

The gap in education level between boys and girls has historically been large in much of the world, and remains so in many parts of South Asia. This gap is thought to be problematic for two reasons: it may reduce women's employment opportunities, and it may negatively affect household welfare, particularly that of children.

A strong association has indeed been documented between household welfare and parental education. Of special interest has been the relationship between mother's education and investment in the human capital of children. A recent example of this interest is a recent paper of Andrabi, Das and Khwaja (2009) who show that, in Pakistan, children with a better educated mother get more help with homework and obtain higher test scores.

For policy markers interested in child welfare and human capital, it is tempting to conclude from such evidence that educating girls is good for future household welfare. There are several potential problems with this inference. The first problem is the possible correlation between education and ability: better educated mothers could also have higher innate ability, so that the association between child welfare and mother's education need not be (fully) causal. The literature has sought to deal with this issue by instrumenting mother's education. In developed countries, examples of this strategy can be found in the works of Black, Devereux, and Salvanes (2005), Oreopoulos, Page, and Stevens (2003), Chevalier (2004), Chevalier, Harmon, O'Sullivan, and Walker (2005), Maurin and McNally (2005), and Galindo-Rueda (2003) who exploit changes in compulsory schooling or in examination standards as instruments. Carneiro, Meghir and Parey (2007) use schooling costs during the mother's adolescence as instruments and find that mother's schooling increases child performance on standardized tests and reduces the incidence of behavioral problems. In developing countries, Andrabi, Das and Khwaja (2009) use the supply of gendered public schools in the mother's birth village as instrument. A similar instrumentation

strategy is adopted for Indonesia by Breierova and Duflo (2004), who use time- and region-varying exposure to a school construction program as instrument.

The second problem is assortative matching in the marriage market: the education of a future mother is typically known at the time of marriage and this may affect matrimonial outcomes.[1] In particular, if educated women are believed to make better mothers, they should attract better suitors and on average be matched with someone whose reproductive success is also predictably higher, such as a better educated man. It follows that any positive relationship between mother's education and child outcomes – whether due to innate ability or to acquired knowledge – would be reinforced by better marriage market outcomes. This point is made by Behrman and Rosenzweig (2002) who, using twin data from the US, find considerable evidence of assortative matching on education.[2] In their study, the relationship between father's education and child schooling is strong and large in magnitude, but the association with maternal education is not significant. Once we allow for assortative matching, findings such as these are difficult to interpret because of the possibility that mother and father education are complements (or substitutes) in child outcomes, something that Behrman and Rosenzweig (2002) do not investigate.

Other issues arise in drawing policy conclusions from a statistical correlation between mother's education and child outcomes. One such issue is the possible presence of labor market general equilibrium effects that erode market returns to mother or father education (e.g., Duflo 2004). In this case observing a cross-section correlation between parental education and household welfare or children outcomes need not be a good predictor of such effects in the future if average education levels increase for the population as a whole. This matters for policy.

Another issue is the channel through which mother's education affects child outcomes: is it

[1] This is particularly true in developing countries where female education levels are low, such as the country we study in this paper.

[2] See also Breierova and Duflo (2004) and Carneiro, Meghir and Parey (2007).

because schooling changes mothers' preferences towards human capital investment; or is it because education raises mothers' productivity in achieving beneficial outcomes. Andrabi, Das and Khwaja (2009), for instance, argue that maternal education could directly increase the mother's productivity or affect her preferences toward children's education, even in a context where her intrahousehold bargaining power is low. The difference between the two is potentially important for policy makers because a productivity effect may require complementary public investments – e.g., vaccination campaign, towards which educated mothers may be more sympathetic. The benefits of mother education may evaporate if these investments are absent. Alternatively, to continue with the same example, if the effect of education is due to better information about the benefits of vaccination, equivalent health benefits may be achievable at lower cost through targeted awareness campaign rather than (presumably more expensive) universal schooling.

Female education is not only an input into a child education or health production process, it also yields a market return that may raise household income. Recent work on employment opportunities by Pitt, Rosenzweig and Hassan (2011) suggests that education is particularly important for women. This is because better nutrition – for instance brought about by higher calorie intake and better health – does not translate into higher physical strength or 'brawn' for women while it does for men. In contrast, market returns to education are the same for men and women. The implication is that, in economies where physical strength is essential in many jobs, women have a comparative advantage in educational investment. Pitt, Rosenzweig and Hassan (2011) use this point to explain why the educational gap between men and women in Bangladesh is now to the advantage of women. Similar trends have been noted elsewhere.[3] Based

[3]In the United Kingdom, the government reported (BBC Tuesday, 30 January 2007, 15:56 GMT) that 47% of 17-30 year-old women had gone into higher education by 2004, compared to 37% of young men. Based on an opinion poll of 2,400 11 to 16-year-olds, the BBC reported (Monday, 27 August 2007, 23:11 GMT 00:11 UK) that about three-quarters (76%) of girls in the UK want to go to university compared with about two thirds of boys (67%).

on this reasoning, educating girls is a good investment when better nourished men take over all brawn-based jobs, and it should be reflected in labor market participation rates of women.

In this paper we use a large dataset from Nepal to examine the relationship between parental education and various indicators of household and child welfare. Unlike several of the previously mentioned studies, the focus of our analysis is *not* on instrumenting parental education, but rather on decomposing the relationship between household welfare and parental education into various components. Instrumentation is motivated by a desire to identify a causal relationship between education and welfare. While commendable, identifying a causal relationship may be hard to achieve due to the marriage market, general equilibrium, and preference/productivity effects outlined above.

We eschew the issue of causality altogether and focus instead on a detailed analysis of the statistical association between parental education and various household and child welfare indicators. In particular, we investigate whether the marginal effect[4] of mother and father education varies with education, and whether mother and father education are complement or substitute. We contrast the marginal effect of an additional year of education granted to a woman with and without marriage market effects. Finally, we test whether parental education has an effect on welfare through a change in preferences or some other channel. Throughout the analysis the focus is on the ability to predict various household outcomes based on parental education. While we include location and ethnicity dummies in our regressions, we do not seek to include other controls that may be channels by which education affects outcomes. The analysis presented here should therefore be seen as aiming to predict household outcomes based on residence and characteristics of the parents at the time of marriage.

We find that increased mother education is generally associated with more beneficial out-

[4] 'Marginal effect' is used here in its commonly accepted statistical or mathematical meaning – it does not imply causality.

comes, especially for children, but this relationship is often non-linear. For many child welfare indicators, there are no gains to female education beyond primary. The marginal effect of female education also depends critically on male education. It follows that there are important marriage market effects: a significant portion of the average effect of female education on child outcomes comes from marrying a better educated man. The evidence we present also suggests that general equilibrium effects may be important: as the average education level rises, the marginal welfare benefit associated with a given level of schooling tends to fall. Finally we present results suggesting that changes in preferences are unlikely to account for much of the effect of parental education on household welfare – and in some cases may even operate in the opposite direction from productivity effects.

These findings contribute to the literature in several ways. Most studies of the effect of female education on welfare have relied on relatively small samples for which it is difficult if not impossible to allow for non-linearities in the effect of female education. We show that there is considerable heterogeneity in the marginal effects of parental education on welfare outcomes depending on education levels. As a result, effects estimated in other studies are difficult to generalize to populations with a different distribution of female education levels.

In terms of the effects themselves, we find that the education of the mother and father are in general similarly associated with household welfare. In particularly, we find that parental education is associated with higher child survival rates, both for boys and girls, and with a smaller number of children overall. These findings contrast with Currie and Moretti (2003), who in a developed country context find that maternal education has significant effects on birth-weight and gestational age. But they agree with Breierova and Duflo (2004) who find that, in Indonesia, female and male education seem equally important factors in reducing child mortality.

Better educated parents also have children who have more schooling and are less likely to work. But the effect can differ dramatically with the level of education. For instance, for women the marginal effect of primary education on child survival is strongest while, for men, it is secondary education. Such findings are to be compared with Plug (2004), who finds weak effects of adoptive mother's schooling on child's schooling but large effects of father's schooling, and Bjoerklund, Lindahl, and Plug (2006) who find strong effects of both adoptive father and mother's schooling. Similarly, Behrman and Rosenzweig (2002) find evidence that father education matters more than mother education. In contrast, Sacerdote (2002) argues that a college educated adoptive mother is associated with a 7% increase in the probability that the adopted child graduates from college. Based of evidence of this kind, Holmlund, Lindahl, and Plug (2006) argue that results from the literature are quite disparate and a consensus has not formed yet. The evidence presented here cautiously suggests a possible reconciliation, namely, that these partially conflicting results are due to marginal effects that vary by education and to different average education levels in the respective study populations.[5]

For some household outcomes, we find that male and female education have different signs. For instance, women married to a man with secondary education are less likely to have had a child in the year preceding the census, but they are more likely to have had a child if they have secondary education themselves. Male education is not correlated the probability that a married man works, but female education is strongly associated with a higher probability that a married woman works. Carneiro, Meghir and Parey (2007) similarly find that maternal education leads to substantial differences in maternal labor supply.

While many authors have controlled for male education when estimating the relationship between female education and welfare, few have been able to obtain estimates of the interaction

[5] We should add, however, that in our data we do not find markedly different marginal effects of mother and father education on child education.

between male and female education: are they substitute for each other in the sense that male education can make up for the lack of female education? Or are they complement in the sense that they reinforce each other? Our findings indicate that male and female education do not reinforce each other in producing beneficial household welfare, but operate instead as substitutes. This is true for all outcomes in which female and male education are clearly positive (child survival, schooling) or clearly negative (number of children, child work). This implies that, with respect to these outcomes, male education can – at least partly – 'make up for' insufficient female education. For outcomes where male and female education have different or ambiguous signs, such as male and female work, we find no strong evidence in either direction.

Because the marginal effect of female education on welfare depends on the education level of her husband, the estimation of the marginal effect of parental education is influenced by assortative matching. We report two types of marginal effects, conditional and unconditional on the education level of the spouse. Unconditional marginal effects can be understood as measuring the effect of increased education if the pairing of spouses in the marriage market was random. Conditional marginal effect correct for marriage market effects. The two are different whenever male and female education are complements or substitutes. We also document a fall in the marginal effect of parental education on welfare over time. This took place at a time when average education levels were rising, suggesting that the marginal effect of education on welfare falls when education levels rise. Results also suggest that marriage market effects play an important part in this fall, accounting for 18% in the reduction in the marginal effect of female education on child survival between older and younger women.

To decompose the marginal effect of parental education into a preference effect and a productivity effect, we construct a proxy for the relative scarcity of women in various marriage cohorts. The assumption is that when women are more scarce on the marriage market, they are able to

orient household welfare choices more in the direction of their own preferences. Interacting this proxy with male and female education yields a test of the effect of education on preferences. We find that educated mothers prefer better educated children, but also prefer their children to work – possibly because they are more likely to work themselves and need help with household chores and family businesses. Educated mothers appear to wish for a smaller family, but this effect is even stronger for educated fathers. Contrary to anticipations, women who are more scarce in the marriage market tend work less outside the home, not more; they also are more likely to have a husband who works. This suggests that, at least for the Nepalese population we study, women prefer not to work.

The paper is organized as follows. In section 2 we introduce the conceptual framework and testing strategy. The data are presented in Section 3 while Section 4 is devoted to empirical results.

2. Testing strategy

The object of this paper is to study the statistical association between male and female education and various household and children outcomes. The main focus is on the marginal effect of an additional year of male or female education on household welfare outcomes, and how this marginal effect varies with household conditions. We also seek to ascertain whether education has an effect on household welfare by affecting preferences or through other channels. We limit our attention to married couples.

2.1. Marginal effects

We examine whether the marginal effect of an additional year of female education raises household welfare more if the husband is himself more educated.[6] Formally, let y denote an outcome of interest, m denote male education, and f female education. We posit:

$$y = g(f, m, v)$$

where v denotes local conditions such as location-specific risk factors and the supply of health and education.

We wish to estimate $\frac{\partial y}{\partial f} = g_f$ and $\frac{\partial y}{\partial m} = g_m$ in a model sufficiently general to allow for $\frac{\partial y^2}{\partial m \partial f} = g_{mf} \neq 0$, i.e., for models other than additively separable in m and f. Suppose that $g_f > 0$ and $g_m > 0$. If m and f complement each other in the production of outcome y, the marginal effect of m on y should increase in f and vice versa – which implies $g_{mf} > 0$. In contrast, if $g_{mf} < 0$, this indicates that female education f is not indispensable to raise outcome y but can be substituted for by higher male education m. If $g_{mf} = 0$, both m and f raise y independently of each other; this is what is typically assumed in regression analysis of the relationship between parental education and household welfare outcomes. If $g_f < 0$ and $g_m < 0$ the interpretation of the sign of g_{mf} is reversed. This arises for instance when outcome y captures lower instead of higher welfare.

Because educated women tend to marry educated men, it is important to distinguish between different types of marginal effects. The first kind of effect we may want to estimate simply

[6] We use the term 'marginal effect' because it is the accepted terminology, not because we wish to imply a causal link.

evaluates $g_f(f, m)$ at the average level of male education $\overline{m}$:

$$g_f^a \equiv g_f(f, \overline{m}, v) \tag{2.1}$$

where $\overline{m} = E[m]$ over the entire population. An estimate of $g_f^a(f)$ is obtained by replacing m with $\overline{m}$ in the estimated function $g_f(f, \overline{m})$ and by calculating $g_f^a(f)$ algebraically for each level of female education f.

When $g_{mf} \neq 0$, however, g_f^a does not represent the average marginal effect of female education if the effect of f on y depends on m in a non-linear way. To deal with this issue, we compute a second kind of marginal effect, which we dub 'unconditional' effect. This is the marginal effect averaging g_f over the population of husbands, assuming that the mix of husbands is the same for all women irrespective of their level of education. In this case, we have:

$$g_f^u(f) = E_m[g_f(f, m)] = \frac{1}{N} \sum_{m \in N} g_f(f, m) \tag{2.2}$$

where N denote the entire population of husbands (and, by a simple abuse of notation, also the number of husbands in N). The marginal effect $g_f^u(f)$ is the average of g_f calculated for a specific value of f, averaging over the level of male education m for all possible husbands in the data.

Formula (2.2) does not, however, control for assortative matching in education levels between husband and wife. For instance, the correlation in education levels between husband and wife in our data is of the order of 0.6-0.7. Our second definition of marginal effects, which we call 'conditional' effects, only averages $g_f(f, m)$ over the husbands that women with education f in

fact marry. Formally we have:

$$g_f^c(f) = E_m[g_f(f,m)|f] = \frac{1}{N_f} \sum_{m \in N_f} g_f(f,m) \tag{2.3}$$

where N_f is the set (and number) of husbands married to women with education level f.[7] In general $g_f^u(f) \neq g_f^c(f)$ unless $g_{mf} = 0$.

If women married at random, the expected marginal effect of increasing f on y would be g_f^u. Because women do not marry at random, however, the expected marginal effect of marginally increasing f depends on the education level of the husband they can expect to marry. This is what $g_f^c(f)$ measures. The difference between g_f^u and g_f^c therefore measures the impact of the marriage market on the expected benefit from increasing f. If f and m are complements or substitutes, the difference between the two can be sizeable.

So far we have focused on the marginal effect of increasing the education of a single woman. If we increase the average education level of all women, there will be general equilibrium effects through the marriage market. To illustrate this idea, imagine that we keep the education of men unchanged but shift the distribution of female education to the right. Matching in the marriage market depends on an individual's rank relative to other potential mates. Consequently, if initially a woman with education level k expected to marry a man with education l, now a woman with the same education k can only expect to marry a may with education $l - s$ with $s \geq 0$. If $g_{mf} \neq 0$, this will affect the marginal return to female education. For instance, if m and f are complements, the expected marginal effect of increasing the education level of all women will be less than what a single woman can hope to achieve by increasing her own education level

[7] This formula will only work if there are enough observations in each cell N_f. In our data, this is the case given that f only takes a finite set of values. In a more continuous case, it may be necessary to modify the formula to adopt a kernel approach, i.e., to define N_f as the set of husbands married to women with education level f' such that $|f' - f| < \kappa$ with k defines a suitable kernel. It would also be possible to include weighting of g_f so that husbands with a wife with education level closer to f get more weight in calculating g_f^u.

before marriage.

To evaluate general equilibrium effects via the marriage market, we divide our sample into two age cohorts. In the older sample, the education gap between men and women is larger than in the younger cohort. We then compute $g_f^u(f)$ and $g_f^c(f)$ for the two cohorts and compare the level of marginal effects between them. The difference between the two illustrates by how much general equilibrium effects reduced the marginal effect of educating women once more women get educated.

2.2. Preferences

Suppose we find that male and female education are associated with better household welfare outcomes. We would like to know why. One possibility is that education makes people more effective at producing certain welfare outcomes. For instance, educated parents may better understand various health risks, their causes, and their cures, as a result may be better at raising healthy children. Since poor health often has a negative impact on nutrition, the two together would reduce child mortality. Similarly, educated parents may be better able to assist children with school work, thereby raising their success in school and hence their motivation to persevere in their studies. Education may also improve welfare by raising income.

Another possibility is that education affects household welfare not by raising parental productivity but by changing preferences directly. For instance, having been to school could make parents more aware of the benefits of education for their children. As a result, they may choose to have fewer, better educated children (e.g., Becker, Murphy and Tamura 1960). Education may also raise people's life ambitions, for instance inducing women to wish for the independence and excitement that work outside the home may offer.

Marginal effects provide no information regarding the channel through which education may

affect household welfare outcomes. We need another methodology. What we propose builds on the work of Porter (2010) and Arcidiacono, Beauchamp, and McElroy (2011). The identifying assumption is that women who are in scarce supply on the marriage market are more empowered and thereby better able to see their personal preferences reflected in household choices. This is an assumption that we make, not one that we test. But with this assumption we can investigate whether education has a systematic effect on preferences as follows. Let d_i denote the relative scarcity of women in the marriage cohort of couple i: the higher d_i is, the fewer women there were relative to men in the marriage age population of the couple. If male and female preferences relative to household outcome y_i differ systematically, then an increase in y_i associated with d_i suggests that women have systematically stronger preferences towards y_i then men, and vice versa if d_i is negatively correlated with y_i.

Now compare two couples j and k with the same d but different levels of female education. If female education increases the preference for y, we should observe a higher y for the couple with a more educated wife. Now increase d and keep everything else constant. Female preferences have a stronger effect on household choices. Hence if education raises the preference of women for y, then y should increase with the product of d and female education f. Reverse the example to focus on male education. A high d means that male preferences are less represented in household choices. Hence y should decrease with the product of d and male education m if male education raises preferences for y. To summarize, if education raises preferences of *both* men and women for y, then we should expect $\frac{\partial y}{\partial df} > 0$ and $\frac{\partial y}{\partial dm} < 0$. And vice versa if education lowers preference for y.

In terms of anticipated results, it is generally believed that women care more about child welfare than men, e.g., mothers who have more say on household decisions steer more resources towards children's education, nutrition, and health (e.g., Fafchamps, Kebede and Quisumbing

2009). Education is believed to reinforce these feelings as it makes more acute the trade-off between child quality and quantity. Regarding fertility, a correlation with female education has often been observed, and this has been interpreted as suggesting that educating women encourages them to wish for smaller families. Finally, regarding female labor market participation, education is often presented as going hand in hand with female empowerment, making it possible for women to insist on the financial independence that a job provides.

3. The data

We use data from the 2001 Nepalese population census. The short population census questionnaire was administered to the whole population. It contains information about many demographic variables, such as the number of dead and surviving children of both sexes. For each child, we have information about their age, gender, school attendance, and education level. The census also recorded whether the child worked in the 12 months preceding the census. The census also contains information about the ethnicity of the parents and their spoken language.

For a randomly selected 11% of the census population, additional information was collected using a second, longer questionnaire. This questionnaire collected information on district of current residence, district of residence 5 years prior to the census, and district of origin. Detailed information is also available on gender, age, education, unemployment, and occupation of the parents. The 11% population census covers approximately 2.5 million individuals in 520,624 households.

The Nepalese Central Bureau of Statistics was kind enough to merge the short and long questionnaire datasets for the 11% of the population covered by the long questionnaire. This provides a very large data set on which we estimate the marginal effect of male and female education. We focus on monogamous couples residing together at the time of the census –

around 340,000 households. Most of these couples are married.

Nepal is a good choice to study the marginal effect of female education. In terms of culture and attitudes, it is similar to its large Southern neighbor, India, with a population that is primarily Hindu. This means that results for Nepal are probably informative about Northern India, and perhaps about other countries in the sub-region as well. Because Nepal is very mountainous, it remained geographically isolated for a long time – the first road to reach the capital Katmandu was built in 1929. Things are changing rapidly, however. Education levels of men and women have increased steadily in the recent past, and the education gap between boys and girls is closing. But there remain important disparities in education across individuals.

We focus our analysis on three groups of dependent variables for which information is available: (1) fertility and child survival; (2) adult employment; and (3) child education and child labor. Since we limit our analysis to co-residing monogamous couples, each household includes a 'husband' and a 'wife'.

Census questions about fertility and child mortality were only asked to women between the age of 16 and 49. They refer to the household as a whole, not to individual children. As measures of fertility we use the total number of reported sons and daughters and a dummy variable that is equal to 1 if the wife of the household head had a live birth in the 12 months preceding the census. For child mortality, we use the proportion of sons and daughters born to the wife who are still alive at the time of the census. We do not have information on the age at which a child died.

Table 1 presents descriptive statistics for these household-specific dependent variables. Across all households with at least one son or one daughter, the average survival rates for sons and daughters are around 94% – only slightly lower for daughters. The average number of ever born sons and daughters reported by each household is higher for boys than for girls. We also note the

Table 1. Household outcome data					
Household outcome variables	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Son survival rate x 100 (1)	221122	94.12	17.69	0	100
Daugher survival rate x 100 (2)	198875	93.98	18.61	0	100
Number of sons (3)	277917	1.60	1.28	0	12
Number of daughters (3)	277917	1.44	1.38	0	12
Live birth during preceding 12 months (3)	277855	6.4%			
Male months of work	340679	9.12	3.93	0	12
Female months of work	340759	4.49	4.81	0	12
Household regressors					
Female scarcity at marriage	340247	-0.04	0.13	-0.83	0.78
Male education	340796	3.75	4.67	0	15
Female education	340796	1.62	3.45	0	15
Male age	340796	42.27	13.02	10	98
Female age	340796	37.54	12.35	12	98
Male mother tongue Nepali	340796	49.9%			
Male hindu	340796	82.6%			
Male brahmin	340796	15.9%			
Male chhetri	340796	16.1%			
Male newar	340796	8.0%			
Female mother tongue Nepali	340796	50.1%			
Female hindu	340796	82.5%			
Female brahmin	340796	15.8%			
Female chhetri	340796	16.1%			
Female newar	340796	7.9%			
(1) Conditional on having at least one son					
(2) Conditional on having at least one daughter					
(3) Conditional on wife between 15 and 49 years of age					

smaller number of households that report having at least one daughter. These figures suggest that there could be underreporting of daughters' births (and death) – although we cannot be sure (e.g., Anderson and Ray 2010).[8] For all women of childbearing age, the census recorded whether they had a live birth in the 12 months preceding the survey. On average, the wife of the household head had a live birth in 6.4% of the households in the sample.

We also examine the employment status of the husband and wife. The reason for doing so is that education raises the return from work. Furthermore, according to Pitt, Rosenzweig and Hassan (2011), in an economy such as that of Nepal where most jobs require physical strength, education increases the comparative advantage of women in outside work relative to home work. We are therefore interested in ascertaining whether women are more likely to work outside the

[8]The smaller number of households reporting having at least one daughter could be because of a parental stopping rule. If households who get a son first stop while households who get a girl first keep trying until they get one sone, there will be more households with at least one son than households with at least one daughter.

home if their husband is more – or less – educated. The census records the number of months during which the husband worked over the 12 months preceding the survey, and similarly for the wife. Information is available for all adult men and women, irrespective of age. As we see from Table 1, husbands work on average 9 months of the year while their wives work 4.5 months of the year.

Table 1 also shows descriptive statistics for the regressors used in the household outcome analysis. Female scarcity if measured as follows. Let N_j^f and N_j^m denote the total number of women and men, respectively, who were born in the same district as individual j, share the same ethno-caste and religion as j, and are at most three years of age apart from j's relevant age. All people in the 11% census are included in the calculation, whether married or not. Most Nepalese couples share the same language, religion and ethnicity. For instance, in 99.7% of the couples where the husband is Hindu, so is the wife. Similarly, in 99.2% of the couples for which the husband is not Hindu, his wife is not Hindu either. For speaking Nepali, the equivalent proportions are 99.4% and 99.1%. Equally high – if not higher – proportions are reported for ethno-caste affiliation. For the latter we rely on the classification used by the Nepalese Central Bureau of Statistics in its surveys. This classification, which is quite detailed, combines caste-like categories with tribal affiliation.

If we take the entire population of married men and women in Nepal, whether in polygamous households or not, the average age of married men three years higher than the average age of married women. To correct for this, if j is a woman (man) we add (subtract) three years to her age when selecting the cohort of men (women) of relevant age. For instance, if j is a 23 year old woman, N_j^f includes all women aged 20 to 26 (of the same ethnicity and religion as j) and N_j^m includes all men aged 23 to 29; if k is a 34 year old man, N_k^f includes all women aged 28 to 34 and N_k^m all men aged 31 to 37. Of course, a woman j need not marry someone in N_j^m –

she may marry someone born in another district, is from another ethno-caste group, or who is more than three years older than her. But N_j^m represents the 'natural' marriage pool of woman j. Hence if $N_j^m > N_j^f$, there are more men than women in j's natural marriage pool, which we assume empowers j and ensures her preferences are better represented in household choices. Similarly for man k: if $N_k^f > N_k^m$, k competes with fewer other men for women in his cohort, and this is assumed to empower him.

Say j and k form couple i. If people do not marry within their cohort, $N_j^m \neq N_k^m$ and $N_j^f \neq N_k^f$.[9] To reflect this, we combine information from both the husband and the wife's natural marriage cohorts to construct the female scarcity variable d_i defined as:

$$d_i = \frac{N_j^m + N_k^m - N_j^f - N_k^f}{N_j^m + N_k^m + N_j^f + N_k^f}$$

By construction d_i is normalized to lie between -1 (extreme female competition) to $+1$ (extreme male competition). A value of 0 means an equal number of men and women in the marriage cohorts of couple i. The average value of d_i is -0.04 in our population of couples, indicating that there are slightly more women than men in their natural marriage cohorts. This is most likely due to the age difference between married men and women, combined with rapid population growth.

Next we present average education levels for husbands and wives. They are low, albeit slightly higher for men. 40% of husbands and 70% of wives have no education at all. The correlation in education levels between husband and wife is 63%. On average a husband in a monogamous couple is 4.7 years older than his wife; the corresponding median is 4 years.

When estimating (2.2) and (2.1) we need to control for local conditions such as local risk

[9] They are the same if the wife is three years younger than her husband and they have the same birth district, ethno-caste category, and religion.

factors and the provision of educational and health services. To do so, we include locality fixed effects. Nepal is divided into 75 districts and further subdivided into 3915 VDCs. All analysis presented here includes VDC fixed effects. We also include dummies for the main language, religion, and ethnicity of the husband and wife. For language, the dummy takes value 1 if the person speaks Nepali, the national language. This dummy is included as control because parents who speak the national language may be in a better position to understand and follow health and nutrition instructions received from teachers and health practitioners – and hence may have better welfare outcomes. Nepali is the mother tongue of half of the husbands and wives.

The religion dummy takes value 1 if the person is Hindu, and 0 otherwise. For caste/ethnicity, we define dummies corresponding to each of the three main categories, Brahmin, Chhetri, and Newar; individuals who are neither get coded as 0. Close to 16% of respondents classify themselves as Brahmin or Chhetri, while another 8% classify themselves as Newar. Together these three categories account for 40% of the sample.

Table 2 reports descriptive statistics for child specific dependent variables. Child education and child labor are recorded for each child separately, but is limited to those children residing in the household at the time of the census. School attendance is a 0-1 variable equal to 1 if the child was attending school around the time of the census. We also have information on the number of completed years of education. School attendance and completed education are only recorded for children between the age of 6 and 15. For children aged 10 and above, we also have a report by the parents on the number of months during which the child worked in the 12 months preceding the census. As documented by Fafchamps and Wahba (2006), child labor is common in rural Nepal, and mostly involves children helping on the family farm or business.

As shown in Table 2, a little over three quarter of the children in the sample are reported as attending school at the time of the census. The number of years of education, averaged over

Table 2. Children outcome data					
Child outcomes	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
School attendance dummy (1)	410211	76.4%			
Number of years of education (1)	410310	2.53	2.53	0	10
Month of work during preceding year (2)	240735	0.97	2.75	0	12
Child specific variables					
Child age	410310	10.31	2.83	6	15
Female child dummy	410310	48.0%			
# older male co-residing siblings	410310	0.72	0.90	0	10
# older female co-residing siblings	410310	0.60	0.83	0	9
Biological mother only (dummy)	410310	1.9%			
Biological father only (dummy)	410310	1.4%			
Household variables					
Male education	410310	3.53	4.51	0	15
Female education	410310	1.25	3.03	0	15
Male age	410310	40.80	8.39	10	93
Female age	410310	36.11	7.58	12	85
Household size	410310	6.29	2.05	3	38
Number children/Household size	410310	0.53	0.14	0.05	0.82
Male mother tongue Nepali	410310	49.2%			
Male hindu	410310	81.9%			
Male brahmin	410310	14.6%			
Male chhetri	410310	16.0%			
Male newar	410310	6.5%			
Female mother tongue Nepali	410310	49.3%			
Female hindu	410310	81.8%			
Female brahmin	410310	14.5%			
Female chhetri	410310	16.0%			
Female newar	410310	6.5%			
(1) Only recorded for children aged 6 to 15					
(2) Only recorded for children aged 10 to 15					

all the children in the sample, is 2.5. For children aged 10 to 15, the average number of months worked during the last 12 months is one.

We control for a number of child-specific variables. The average age of the child in the sample is 10.3. Some 48% of children are girls. To control for household composition effects and possible sibling competition for resources, we include controls for the number of male and female co-residing elder siblings.[10] Older siblings can help parents around the house or household business and thus help younger siblings to attend school and dispense from work. The average child in the sample has 0.72 older male sibling and 0.6 older female sibling co-residing in the household. The proportion is lower for female siblings presumably because girls marry earlier.

The census also recorded information on whether the child is living with his/her biological parents or not. Most children (88.7%) live with both biological parents; 6.69% of children live with their biological mother while 2.45% live with their biological father. The rest (2.16%) do not live with their biological parents and are ignored from the analysis. We also limit our analysis to children living with a married couple, so that we have information on both husband and wife. In this subsample, 96.7% of the children live with both their biological parents.

Table 2 also reports the same parental statistics as those reported in Table 1, but for the average child in the sample. Parental age is slightly lower than in Table 1, which is not surprising since older parents are less likely to have children in the 6 to 15 age range. Other descriptive statistics are very similar and need not be discussed further. In the children regression we also control for household size and dependency ratio. As seen in Table 2, for the average child in the sample the household has 6.3 members. The dependency ratio is simply taken as the number of children in the total. For the average child, half of the household members are children. There is considerable variation across households in terms of size and dependency ratio.

[10] We experimented with other sibling composition varibles, such as rank or total number of male and female siblings. But older siblings gives the best fit.

4. Empirical results

For household-specific variables, we estimate a model of the following form:

$$\begin{aligned} y_{iv} &= \theta_0 d_{iv} + \theta_1 d_{iv}(m_{iv} - \overline{m}) + \theta_2 d_{iv}(f_{iv} - \overline{f}) \\ &\quad + \beta_0 m_{iv} + \beta_1 m_{iv}^2 + \beta_3 f_{iv} + \beta_4 f_{iv}^2 + \beta_5 m_{iv} f_{iv} \\ &\quad + \alpha_0 h_{iv} + \alpha_1 h_{iv}^2 + \alpha_3 w_{iv} + \alpha_4 w_{iv}^2 + \alpha_5 h_{iv} w_{iv} \\ &\quad + \gamma_1 m_{iv} h_{iv} + \gamma_2 f_{iv} w_{iv} + \sum_d \delta_d D_{iv} + u_v + \varepsilon_{iv} \end{aligned} \tag{4.1}$$

where y_{iv} denote an indicator of interest for household i in VDC v. As in Section 2, m_{iv} and f_{iv} denote the education level of the husband and wife while d_{iv} denotes the relative scarcity of women in the marriage cohort of the couple. Variables h_{iv} and w_{iv} denote the age of the husband and wife, respectively. Language, religion, and ethnicity dummies, for both the husband and the wife, are represented by D_{iv}. The regression include a VDC fixed effect u_v. Robust standard errors, clustered by VDC, are reported throughout.

For child-specific variables such as school attendance, education, and child work, equation (4.1) is expanded to include child-specific age and gender dummies, the log of household size, the dependency ratio (calculated as the share of children in the household), the number of older male and female co-residing siblings, and whether the child lives with only a biological mother or father. For education variable children aged between 6 and 15 are included. The child work question was only asked for children aged 10 and above.

Estimated coefficients for the household regressions are summarized in Table 3; those for children regressions appear in Table 4. We follow the outline laid out in Section 2 and begin by discussing marginal effects. We discuss marriage market effects later.

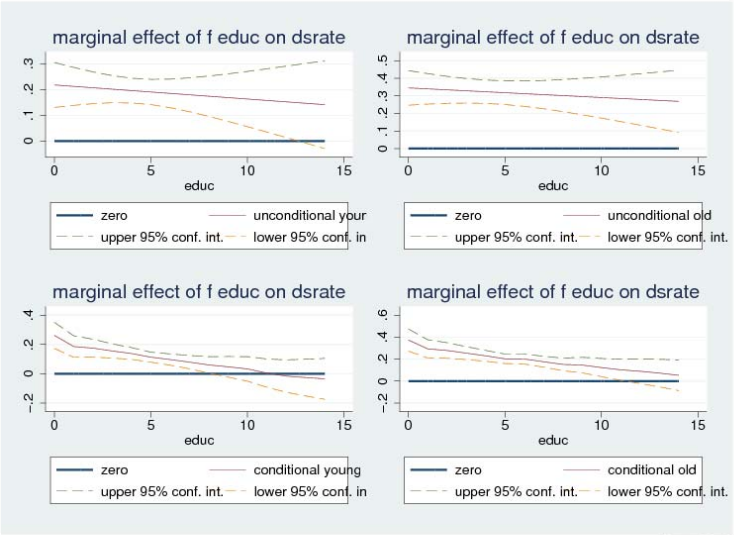

Figure 4.1: Figure 1. Daughter survival rate and female education

4.1. Marginal effects

Hence, our first interest lies in estimating $g_f^u(f)$ and $g_f^c(f)$ for various dependent variables. Since these estimates vary with f, they are best represented graphically. We begin with the survival rate of daughters. Estimates of marginal effects $g_f^u(f)$ and $g_f^c(f)$ are reported in Figure 1. The two upper panels present unconditional marginal effects, that is, without taking into account marriage market effects. The left-hand figure reports $g_f^u(f)$ for wives below the median age of 35 while the right-hand panel reports $g_f^u(f)$ for wives aged 35 and over. The lower two panels of Figure 1 do the same thing for conditional marginal effects $g_f^c(f)$ that control for the education level of the husbands that wives of different education level are likely to marry. Figure 1 also reports robust 95% confidence intervals around the marginal effects.

Given the functional form of (4.1), the unconditional marginal effect of female education over the whole sample is simply:

$$g_f^u(f_{iv}) = \beta_3 + 2\beta_4 f_{iv} + \beta_5 E[m_{iv}] + \gamma_2 E[w_{iv}] \tag{4.2}$$

We see from Figure 1 that the unconditional marginal effect of an additional year of female education is large for uneducated women: one additional year of education for an illiterate wife increases the daughter survival probability by 0.2 to 0.35 percentage points. This effect is large given that the average survival rate is around 94%. For instance, according to these estimates, increasing female education by 5 years (from illiterate to primary) would to reduce daughter mortality by around 1 percentage point. The graph also shows that the unconditional marginal effect falls with education. This is hardly surprising given that β_4, the coefficient of female education squared, is strongly negative in Table 3.

The bottom half of Figure 1 reports the conditional marginal effect of female education, which is calculated as:

$$g_f^c(f_{iv}) = \beta_3 + 2\beta_4 f_{iv} + \beta_5 E[m_{iv}|f_{iv}] + \gamma_2 E[w_{iv}|f_{iv}] \tag{4.3}$$

Coefficient β_5 corresponds to the male and female interaction term $m_{iv}f_{iv}$ in regression (4.1). If male and female education are correlated (sample correlation is 0.63), for educated women we have $E[m_{iv}|f_{iv}] > E[m_{iv}]$. Consequently, other things being equal, if $\beta_5 < 0$ the conditional marginal effect of education $g_f^c(f_{iv})$ will tend to be lower for educated women than the unconditional effect $g_f^u(f_{iv})$. This is to be expected: a negative β_5 means that the marginal effect of female education falls with male education, implying that male and female education are easy substitute in the production of daughter survival. Given that educated women are more likely

to be married to an educated man, $g_f^u(f_{iv})$ overestimates the beneficial effect of female education in the population at large.

A similar effect arises through the correlation between female age and education, which is negative (-0.24). This means that, for educated women, $E[w_{iv}|f_{iv}] < E[w_{iv}]$. Coefficient γ_2 corresponds to the female age-education interaction term $f_{iv}w_{iv}$ in (4.1). If $\gamma_2 > 0$, this generates an additional force in equation (4.3) that pushes $g_f^c(f_{iv})$ below $g_f^u(f_{iv})$. The intuition behind this result is simple. A positive γ_2 means that the marginal effect of education is higher for older women. This may be because, in our sample, the few older women who managed to get some education were given information that was particularly useful to improve child survival at a time when health and nutrition conditions were poorer than they are now. Younger women are, on average, better educated but sanitary conditions may have improved, in which case the marginal effect of education of child survival could be smaller. This is what a significantly positive γ_2 suggests.

Given that $\beta_5 < 0$ and $\gamma_2 > 0$ in Table 3 for daughter survival, and given the sample correlations discussed earlier, $g_f^c(f_{iv}) < g_f^u(f_{iv})$ for educated women. This is indeed what Figure 1 indicates: the marginal *conditional* effect falls faster with education than the unconditional effect. If we also consider the confidence interval for both types of marginal effect, we see that educating a woman beyond middle school does not have a significant effect on daughter survival once we take into account the education level of the husbands that a more educated woman is likely to marry.

The conditional marginal effect $g_f^c(f)$ measures the effect that giving an additional year of education to a single woman would have on household and children outcomes for that woman. This is the kind of welfare effect that parents, for instance, would have in mind when they decide whether to educate their daughter or not. But if all women were to get more education, things

would be different because the marriage market would be affected.

In the recent past, female education has improved in Nepal and older cohorts of married women in our sample received less education than younger cohorts. To illustrate how this affects $g_f^c(f)$ and $g_f^u(f)$, let us compare the left-hand and right-hand panels of Figure 1 which compare older to younger cohorts of married women. For women below the median age of 35, the unconditional marginal effect is computed as:

$$g_f^u(f_{iv}|w_{iv} < 35) = \beta_3 + 2\beta_4 f_{iv} + \beta_5 E[m_{iv}|w_{iv} < 35] + \gamma_2 E[w_{iv}|w_{iv} < 35] \tag{4.4}$$

while for women above the median age the formula is:

$$g_f^u(f_{iv}|w_{iv} \geq 35) = \beta_3 + 2\beta_4 f_{iv} + \beta_5 E[m_{iv}|w_{iv} \geq 35] + \gamma_2 E[w_{iv}|w_{iv} \geq 35] \tag{4.5}$$

Consider the determinants of the difference

$$D_f^u \equiv g_f^u(f_{iv}|w_{iv} \geq 35) - g_f^u(f_{iv}|w_{iv} < 35)$$

The terms in β_3 and β_4 cancel out. Regarding the third term, we have already noted that $\beta_5 < 0$: male education is beneficial to daughter survival. Because education levels have risen over time, younger women on average marry better educated husbands, i.e.:

$$E[m_{iv}|w_{iv} < 35] = 4.8 > E[m_{iv}|w_{iv} \geq 35] = 2.9$$

It follows that, other things being equal, the effect of the β_5 term on D is positive. Regarding

the γ_2 term, we have:

$$E[w_{iv}|w_{iv} < 35] = 26 < E[w_{iv}|w_{iv} \geq 35] = 46$$

Since $\gamma_2 > 0$,the effect of the β_5 term on D_f^u is also positive: the marginal effect of sending a daughter to school for one more year on the survival chances of their female offspring was higher in older cohorts than it was for parents of younger cohorts. How much of this reduction is due to marriage market effects? We have:

$$D_f^u = -0.019(2.9 - 4.8) + 0.008(46 - 26) = 0.036 + 0.16 = 0.196$$

which shows that the γ_2 effect dominates. The marriage market effect is not negligible, however, since it accounts for 18% of the reduction in the marginal effect of female education between older and younger women.

A similar comparison can be conducted for conditional marginal effects $g_f^c(f)$. The relevant formula is:

$$g_f^c(f_{iv}|w_{iv} < 35) = \beta_3 + 2\beta_4 f_{iv} + \beta_5 E[m_{iv}|f_{iv}, w_{iv} < 35] + \gamma_2 E[w_{iv}|f_{iv}, w_{iv} < 35]$$

for women below median age, and similarly for those above. Unlike in the unconditional case, the difference between the β_5 terms is not constant across education levels f_{iv}, and similarly for the γ_2 terms. Hence the difference between the two marginal effects is not a parallel shift as was the case for D_f^u.

To visualize these patterns and make comparison easier, in Figure 2 we overlay in a single

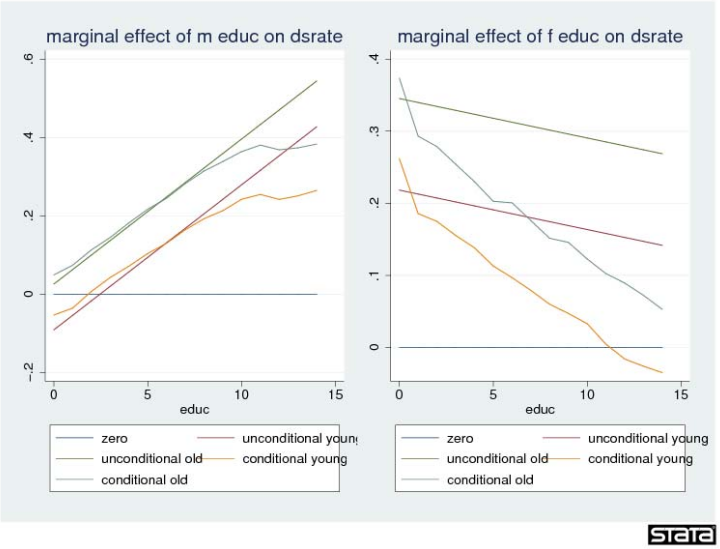

Figure 4.2: Figure 2. Male and female education and daughter survival rate

graph the four marginal effect loci reported in Figure 1.[11] We also report similarly calculated marginal effects for men. The male and female Figures are very different. For women, the marginal effect of education is highest at low levels of schooling – e.g., primary and, to a lower extent, middle school. In contrast, for men the marginal effect of schooling on daughter survival rates is zero at low levels of schooling but increases strongly with education. As for women, the comparison of the older and younger cohorts indicate that the marginal effect of education has fallen over time. But the shift is smaller, however. We also note a weaker effect of marriage market conditions on marginal effects for males: the difference between conditional and unconditional curves is less pronounced than for female education.

[11] Confidence intervals are omitted to improve visibility.

We calculated similar marginal effects for son survival rates. The results, not shown here to save space, are very similar to those reported in Figure 2 for girls.

Next we look at fertility. We begin with the number of sons and daughters of the couple. Marginal effects are summarized in Figure 3 for sons. The Figure for daughters is similar and is not shown here to save space. We see that the marginal effect of female education on the number of sons is negative throughout, but the effect is much stronger at higher levels of education. There is a difference between unconditional and conditional curves, but the difference is not large. As was the case for child survival, comparing the two age cohorts indicates that the beneficial effect of female education has fallen over time.

For men, male education is initially associated with a small but positive marginal effect on the number of sons – men with one or two years of primary education tend to have more sons than those with no education at all. The marginal effect of male education becomes negative for education levels above primary. As for women, we see an upward shift in marginal effects from the old to the young cohort, which implies that young husband with some years of primary education tend to have more sons than similarly educated older men. This may reflect income effects and an increase in returns to education as the Nepalese economy becomes more urbanized with more emphasis on specialization and non-farm activities (Fafchamps and Shilpi, 2005).

Next we turn to childbirth in the 12 months preceding the census. Results are summarized in Figure 4. For male education, the effect is qualitatively similar to that for the number of sons and daughters. Female education, however, shows a markedly different pattern: instead of observing marginal effects becoming more negative with education, we observe an initially negative effect at small levels of education that turns into a positive marginal effect at higher levels of female education. In other words, among poorly educated women, increasing education by one year tends to reduce the likelihood of having a child in the 12 months preceding the

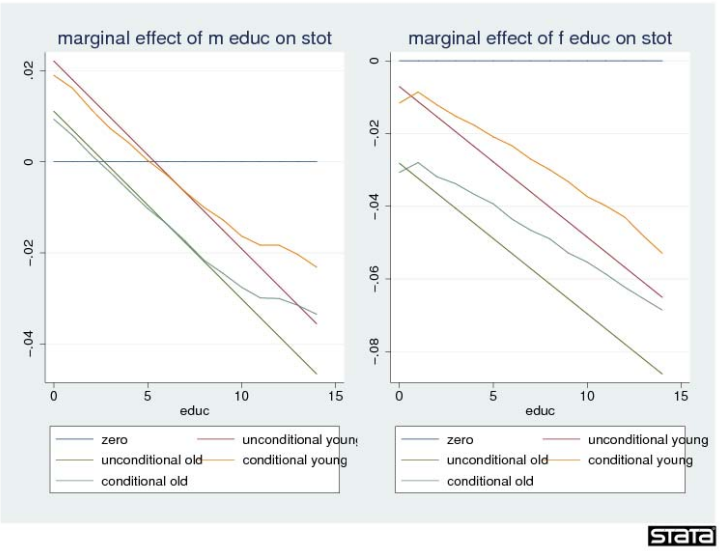

Figure 4.3: Figure 3. Number of sons and education

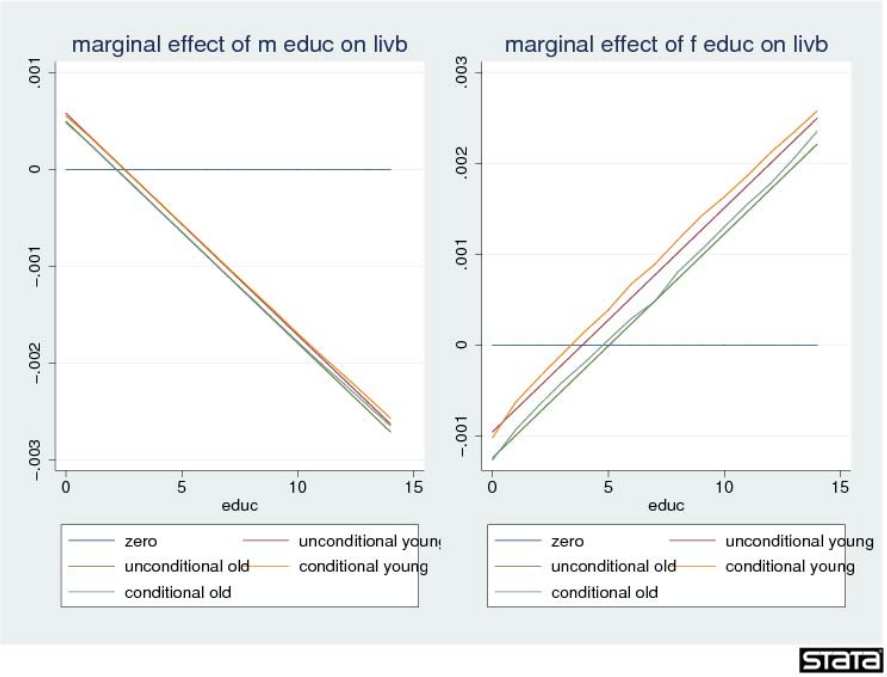

Figure 4.4: Figure 4. Live birth in preceeding 12 months

census. But for women having complete primary education, one additional year of education is associated with a increased probability of having a child in the year before the census. We also note that, for men, the negative marginal effect of education on fertility is more negative for the younger cohort. The opposite is true for women.

If we compare Figures 3 and 4 we get a very different picture regarding the marginal effect of post-primary education on fertility. Taken together, these results indicate that a more educated women of a given age has fewer children but is more likely to have had a child in the preceding year. This is likely to be due to a catching up effect, educated women having children later in

their adult life.

In Figure 5 we examine the relationship between school attendance and the education of the parents. The reported coefficients come from the child-specific regressions in Table 4. For memory, these regressions control for age and gender together with VDC fixed effects and parental characteristics. From the left-hand panel of Figure 5 we see that the marginal effect is high at low levels of father education but falls to zero for higher-secondary education levels of the father. We observe no difference across age cohorts and little marriage market effect. The effect of mother education on school attendance is also large, albeit smaller than that of father education: the marginal effect of going from no education to one year of primary education raises school attendance of children by around 3 percentage points for fathers but only by around 1.2-1.4 percentage point for mothers. For mother's education the unconditional effect falls less rapidly than for father's education, but once we correct for marriage market effects the marginal effect of mother's education is found to fall steeply. In other words, in Nepal there is a stronger association between school attendance and father education than with mother education. We nevertheless see that the marginal effect of female education is higher for the younger cohort of mothers, suggesting that the effect has increased over time – possibly because the availability of school has improved.

The relationship between completed schooling and parental education is displayed in Figure 6. Here too we have controlled for the age and gender of the child (see Table 4). The general pattern is similar to that observed for school attendance, although there are important differences. We again see a strong marginal effect of father education on total schooling, although this marginal effect is much smaller for the younger cohort of fathers. The marginal effect of female education is initially higher than that of men – at least for the older cohort – but falls more rapidly. Female marginal effects, however, are massively smaller for the younger cohort of

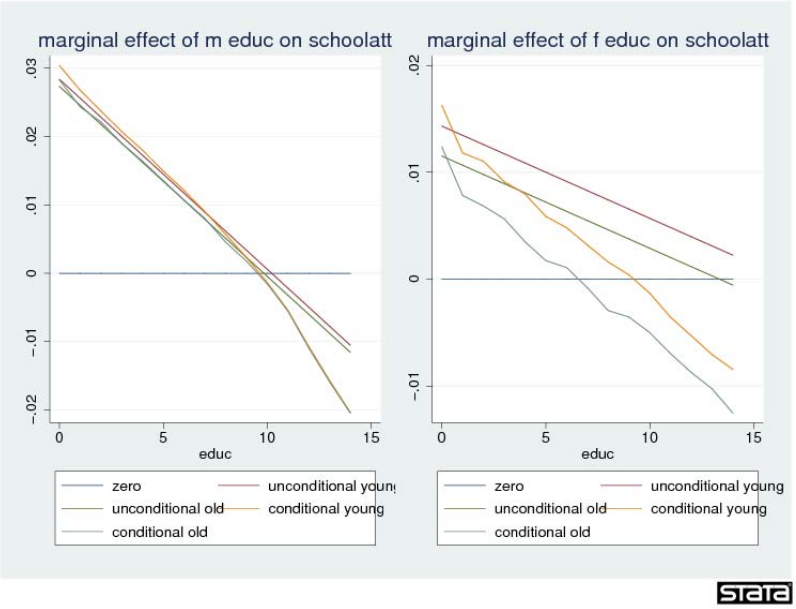

Figure 4.5: Figure 5. School attendance of children and education of parents

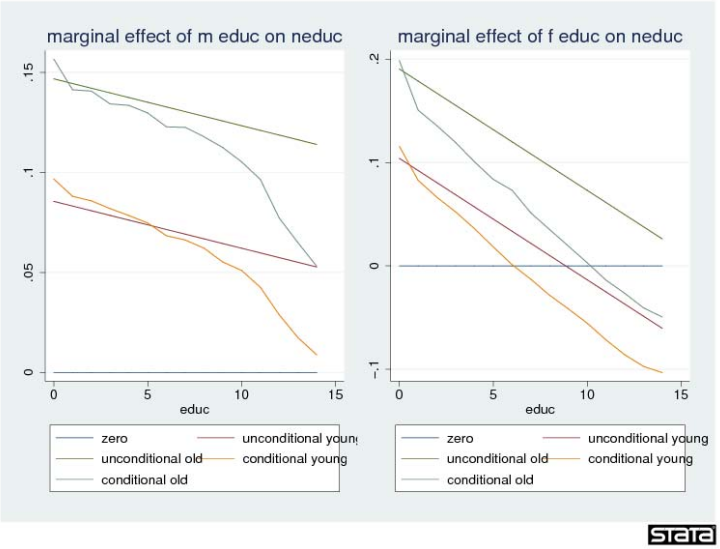

Figure 4.6: Figure 6. Years of schooling of children and education of parents

mothers.

Conditional marginal effects fall more rapidly with education than unconditional ones. This is true for both fathers and mothers. This finding is in line with coefficient estimates reported in Table 4: β_5, the coefficient of the male-female education term, is significantly negative while γ_2, the coefficient of the age $\times$ education term, is positive and significant. The two effects thus operate in the same direction, hence the steeper conditional marginal effects. We also note that $\beta_5 < 0$ implies that male and female education are partial substitutes as far as child schooling is concerned. This substitutability is what generates strong marriage market effects, given the strong correlation between male and female education in married couples.

Does the effect of parental education carry over to child work? The answer is yes, as we can

see from Figure 7. Father education has a particularly strong negative effect on the likelihood of that a child aged 10 to 15 worked in the 12 months preceding the census. The effect falls with father education, probably because children of fathers with completed secondary education hardly ever work. But otherwise the marginal effect of father education is stable: conditional and unconditional effects are very similar and do not differ in any meaningful way between age cohorts. The marginal effect of mother education is also negative at low levels of education, but it is much smaller in magnitude. We also observe steeper conditional marginal effects and an large upward shift in marginal effects between the older and younger cohorts. For young cohorts, the conditional marginal effect of female education on child work is not significant except at very low levels of education – i.e., below 2 years of primary education. For highly educated women – e.g., completed secondary and above – marginal effects are significantly positive, not negative. The likely explanation is that educated women are more likely to work outside the house and therefore more likely to need the assistance of their children in their work.

Figure 8 documents the effect of female education on female work. As we can see from the right-hand panel, the marginal effect of female education on female work is massively positive for women with education above primary. This is especially true for the older cohort. For women with less than full primary education, however, the marginal effect of education is significantly negative – particularly among younger cohorts. This means that young women in our sample who received one year of primary education work less than those who received none.

From the right panel of Figure 8, we also see that the effect of male education on female work is strongly negative, and increasingly so for better educated men. One possible interpretation is that better educated men earn more. As a result, household with a better education male head demand more home-produced goods and services, which are typically provided by the wife who then does not 'work' outside the home (Fafchamps and Shilpi 2005). This effect of

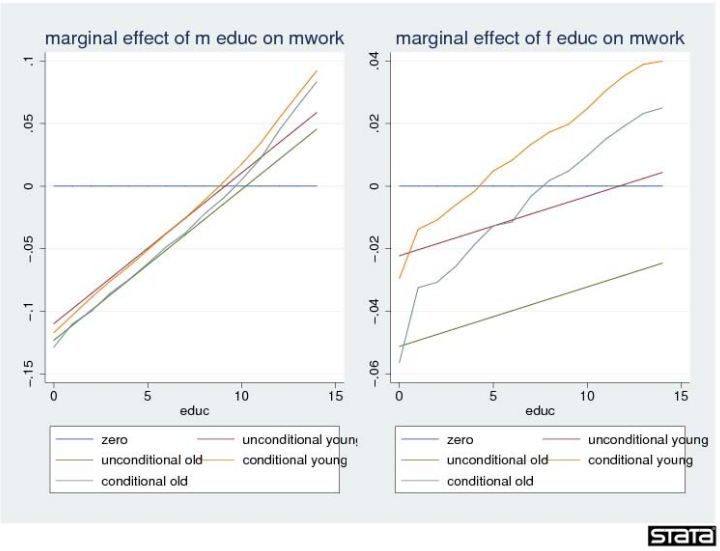

Figure 4.7: Figure 7. Months of child work and education of parents

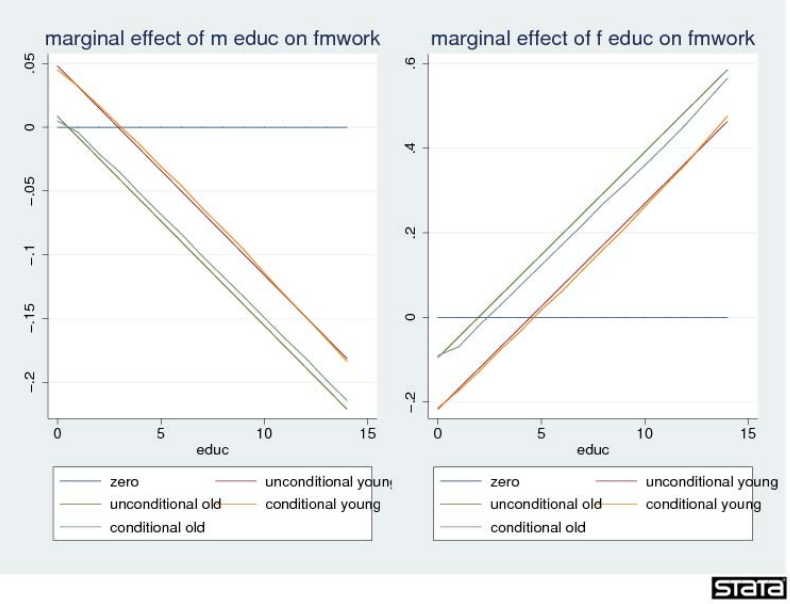

Figure 4.8: Figure 8. Months of wife's employment

male education on female work is nevertheless small or inexistent for levels of education below completed primary, and they have tended to decline over time. Finally, we note that since conditional and unconditional effects are virtually identical for male and female education, the negative marginal effect of female primary education is not due to marriage market effects.

It is instructive to compare the results in Figure 8 to those regarding male work, which are shown in Figure 9. The left-hand panel shows little systematic relationship between male work and male education – presumably because most married adult males work, irrespective of education. We note a difference in marginal effects between younger and older cohorts, but this difference is probably due to the fact that older men are less likely to work. Turning to

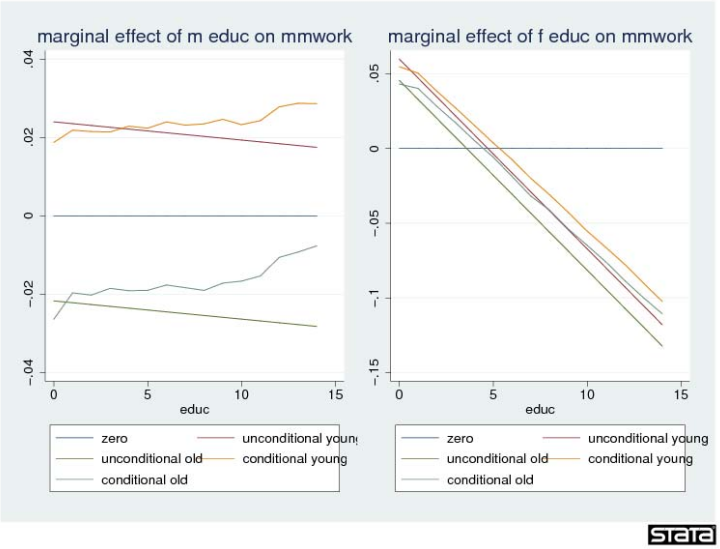

Figure 4.9: Figure 9. Months of husband's employment

the right-hand panel of Figure 9, we observed that female education has a positive marginal effect on male work at less than completed primary levels. But the effect becomes negative for female education above primary. To interpret these results, we should keep in mind that the overwhelming majority of employed adult males are not in wage employment but are self-employed. The dependent variable is the number of months during which they work in the preceding 12 months. What Figure 9 indicates is that men who have married an educated women tend to work fewer months in the year compared to men who have married a slightly less educated wife. Since we have seen from Figure 8 that women with completed secondary education are more likely to work, this suggests that female work has an income effect on male labor supply.

4.2. Marriage market and preferences

We now turn to the second part of our analysis and look for evidence that education affects household welfare by changing individual preferences. For memory, the regression we estimate is of the form:

$$y_{iv} = \theta_0 d_{iv} + \theta_1 d_{iv}(m_{iv} - \overline{m}) + \theta_2 d_{iv}(f_{iv} - \overline{f}) + \text{ other regressors}$$

Tables 3 and 4 report estimates for θ_0, θ_1 and θ_2. Since we subtracted average male education $\overline{m}$ from m_{iv} and similarly for f_{iv}, the coefficient of d_{iv} can be interpreted as the average marginal effect of d_{iv} on y_{iv}. A significantly positive θ_0 therefore indicates that when women have more power in the household, they reorient household choices in favor of y_{iv}. A positive θ_1 indicates that educating women increases their preference for y_{iv} while a negative θ_2 similarly indicates that educating men increases they preference for y_{iv}.

The estimates for θ_0 reported in Table 3 suggest that women on average prefer larger families more than men. They also prefer a working husband, but prefer not to work themselves. We also see that when women have more power in the household, daughter survival and, from Table 4, school attendance are lower. These findings contradict many implicit assumptions about female preferences that economists and policy makers often make, e.g.: that women prefer smaller families (e.g., Ashraf, Field and Lee 2010); that they prefer to invest in children more than men do; and that married women like to work outside the home but husbands prevent them from doing so. Of course these findings are predicated on the maintained assumption that relative female scarcity on the marriage market translates into more female empowerment in married couples, an assumption we are not in a position to test with our data. But similar assumptions have been made by others, and they underlie for instance the recent work of Porter (2010) and

Arcidiacono, Beauchamp, and McElroy (2011).

We now examine whether education changes these preferences. In Table 3 coefficients estimates for θ_1 and θ_2 are mostly non-significant, but we find that $\widehat{\theta}_1 > 0$ for the number of sons and daughters, indicating that, in couples where husband's preferences are more strongly represented, better educated husbands few children. This suggests that education reduces men's preference for large families. We see a similar effect for female education and the number of sons ($\widehat{\theta}_2 < 0$), but no similar effect for daughters. Educating women has often been presented as an effective way of reducing fertility because it reduces women's desired number of children. These results do not contradict this interpretation, but they suggest that a similar – and perhaps stronger – effect is also present for father education.

Regarding work, we find that better educated wives have a lower preference for a working husband but better educated husbands have a preference for a working wive ($\widehat{\theta}_1 < 0$). Goldin (2006), in the Ely Lecture to the American Economic Association, observed a similar pattern in the US in the first half of the 20th century, where educated women did not participate in the labor force. She interprets this as a sign that, for women at the time, not working was a status symbol, something women aspired to. The same process may be at work in Nepal where work conditions are not particularly good for women and the jobs available to them are not particularly rewarding.

We find stronger results for child-specific regressions in Table 4, but not necessarily those we anticipated. As anticipated, better educated mothers seem to prefer better educated children: $\widehat{\theta}_2 > 0$ in both the school attendance and years of schooling regressions. But they also prefer children who work, albeit the coefficient is only marginally significant. In contrast, better educated fathers appear to prefer less educated children – $\widehat{\theta}_1 > 0$ in both cases – while also preferring children who work. These findings suggest that the strong positive association between

father education and that of children that was reported in Figures 5 and 6 is not driven simply by a change in father preferences. This leaves productivity effects (educated fathers can better assist children in school) and income effects (educated fathers earn more and can afford to send their children to school) as most likely explanation for this association. A similar conclusion can be drawn for child work: the effect of parental education on reducing child work is not driven primarily by a change in preferences due to education, but rather to the income and productivity benefits that education generate.

5. Conclusion

Using data from the 2001 Nepalese population census, we have examined in detail the relationship between male and female education and a number of household welfare indicators. Taking advantage of the large number of observations, we studied how the marginal effects of male and female education vary with education. We used the phrase 'marginal effect' throughout because it is the accepted definition of the mathematical objects we have focused on. We do not, however, claim to have identified *causal* effects of education on household welfare. Still, the relationships we study here are interesting in their own right and have received a considerable amount of attention in the past literature. Our contribution is to show that average effects can be misleading, and that the matching of spouses in the marriage market does affect the benefits one may expect from raising education levels, especially when male and female education are substitutes in achieving a given desirable outcome.

In general, we observed that, for the household outcome variables we investigate, the beneficial effects of female education are either concentrated at the lower end or upper end of the education spectrum. For child survival, it is the primary education of mothers – and the secondary education of fathers – that are associated with better outcomes, i.e., less mortality. We

suspect that at least part of the positive effect of male secondary education is not a direct effect of education itself but rather is due to higher household incomes. For fertility, female secondary education matters more. For child schooling and school attendance, we found a strong positive association between beneficial outcomes and father education. The relationship with female education is positive as well but smaller in magnitude. The marginal effect of female education on child work is negative for primary education but positive – i.e., more child work – for completed secondary education and above. Given that married women with high levels of education are much more likely to work, this suggests that educated women rely, to some extent, on children aged 10 to 15 to assist them in their multiple tasks.

An original contribution of this paper has been to contrast conditional and unconditional marginal effects of education. Unconditional effects are those that are obtained directly from estimated parameters. They approximate what household outcomes a women would be observed to have if she had more education but her husband was unchanged. Conditional effects also take into account the fact that a better educated women is likely to be married to a better educated man. If the education levels of men and women are substitutes (or complements), this will affect the marginal relationship between female education and household outcomes. If the statistical relationships documented here were a good approximation of the anticipated household welfare benefits from an additional year of female education, conditional marginal effects represent what parents may expect the effect of their investment to be, taking into account how educating their daughter would affect her prospects on the marriage market.

We found that the marginal effect of female education has changed over time in the sense that it is different for younger and older cohorts of married women. In general, the beneficial effects of female education are lower for younger cohorts. If this were indicative of a general trend, it implies that the education of girls in the future cannot be expected to have as large

a positive effect on household welfare as it had in the past. To the extent that parents invest in girl education because of the anticipated effects on household welfare, this might seem like bad news. Of course, this fall in marginal effects is presumably more than compensated by the falling cost of educating a girl as the number of schools has increased.

Finally, we examined the data for evidence that education leads to systematic changes in preferences. Identification of this relationship is achieved by assuming that scarcity of women on the marriage market empowers women. While we are unable to test this assumption with our data, it has been commonly made in the literature. Findings are only partially in agreement with assumptions often implicitly made by researchers and policy markers alike. We find that educated mothers prefer better educated children, but also prefer their children to work – possibly because they need help with household chores and family businesses. Educated mothers appear to wish for a smaller family, but a similar and stronger effect is also found for educated fathers. Finally, contrary to anticipations, empowered women work less outside the home, not more, suggesting that for the period covered by our data Nepalese women did not have a strong preference for work outside the home. We also find that educated men do prefer a working wife. These results cast some doubt on commonly made assumptions about *purdah* – commonly practiced in the sub-region – being imposed by men against the will of women. The main lesson from this part of our paper is that development practitioners and policy makers should probably refrain from making assumptions about gender-specific preferences without first checking what these preferences actually are. The evidence presented here suggest that we know less than we think we do. More work is needed in this area.

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Table 3. Household outcome regressions

	Son survival		Daughter survival		Number of sons		Number of daughters		Birth in year		Husband works		Wife works	
Marriage market variables	**coef**	**t**	**coef**	**t**	**coef**	**t**	**coef**	**t**	**coef**	**t**	**coef**	**t**	**coef**	**t**
Female scarcity at marriage	-0.500	-1.242	**-1.026****	-2.412	**0.173*****	6.570	**0.168*****	6.125	-0.006	-1.469	**0.566*****	6.869	**-0.458*****	-4.247
Female scarcity x male education (1)	-0.118	-1.549	-0.058	-0.684	**0.023*****	4.532	**0.018*****	2.800	-0.000	-0.324	-0.015	-0.797	**-0.075*****	-3.556
Female scarcity x female education (1)	0.014	0.146	0.055	0.525	**-0.014****	-1.960	0.000	0.001	-0.002	-1.631	**-0.064****	-2.248	-0.010	-0.284
Education and age variables														
Male education	-0.212***	-3.599	-0.286***	-4.419	0.041***	11.995	0.025***	7.581	0.001	0.806	0.084***	4.397	0.100***	6.490
Male education squared	0.015***	4.860	0.019***	4.937	-0.002***	-10.896	-0.002***	-9.679	-0.000***	-2.699	-0.000	-0.183	-0.008***	-5.780
Female education	0.181***	2.746	0.083	1.297	0.022***	6.185	0.013***	2.971	-0.001	-0.652	0.061***	3.618	-0.387***	-14.954
Female education squared	-0.009**	-2.283	-0.003	-0.646	-0.002***	-8.258	-0.002***	-5.722	0.000**	2.046	-0.006***	-5.494	0.024***	10.700
Male education x female education	-0.018***	-4.892	-0.021***	-5.381	0.002***	7.809	0.001***	5.908	0.000	0.122	0.002*	1.797	-0.000	-0.011
Male age	-0.079	-1.438	-0.188***	-3.605	0.062***	23.873	0.053***	18.357	-0.004***	-4.721	0.215***	19.657	-0.056***	-5.283
Male age squared	-0.002*	-1.852	0.001	0.614	-0.001***	-17.848	-0.001***	-15.181	0.000***	4.193	-0.003***	-13.244	0.001***	6.127
Female age	0.079	1.152	0.141**	2.057	0.140***	35.758	0.144***	34.319	-0.012***	-12.395	0.012	1.244	0.240***	22.716
Female age squared	-0.007***	-3.438	-0.005**	-2.479	-0.002***	-21.741	-0.002***	-19.593	0.000***	6.141	-0.000	-1.374	-0.001***	-5.539
Male age x female age	0.006**	2.159	0.001	0.467	0.002***	9.674	0.001***	7.555	-0.000	-1.491	0.000	0.285	-0.003***	-5.864
Male age x male education	0.005***	4.325	0.007***	5.273	-0.001***	-7.529	-0.000***	-3.235	-0.000	-0.252	-0.002***	-5.475	-0.002***	-8.334
Female age x female education	0.006***	4.111	0.008***	5.000	-0.001***	-12.301	-0.001***	-10.177	-0.000	-0.670	-0.000	-1.116	0.006***	17.186
Language, religion, and ethnicity controls														
Male mother tongue Nepali	-0.358	-0.718	0.065	0.147	-0.004	-0.129	0.034	1.330	0.001	0.253	-0.219**	-2.050	0.139	1.145
Male hindu	-0.223	-0.342	-1.861***	-2.775	0.019	0.602	-0.010	-0.217	-0.011	-1.375	0.030	0.284	-0.207	-1.509
Male brahmin	0.769	0.899	1.638	1.285	-0.146***	-3.491	-0.050	-1.002	0.008	0.746	0.151	0.932	-0.051	-0.293
Male chhetri	-0.413	-0.590	1.326*	1.670	-0.058	-1.446	-0.011	-0.233	0.010	1.044	0.059	0.525	-0.389**	-2.169
Male newar	0.746	0.755	1.222	1.289	-0.106**	-2.229	-0.025	-0.394	-0.011	-1.023	0.600***	4.560	-0.118	-0.513
Female mother tongue Nepali	0.371	0.770	0.260	0.648	0.009	0.308	-0.017	-0.632	-0.002	-0.431	-0.019	-0.204	-0.201*	-1.740
Female hindu	-0.020	-0.031	1.435**	2.134	-0.035	-1.076	-0.023	-0.482	0.006	0.749	0.171*	1.719	0.217	1.429
Female brahmin	0.291	0.341	-0.877	-0.695	0.054	1.308	-0.007	-0.141	-0.013	-1.176	-0.106	-0.687	0.144	0.834
Female chhetri	1.455**	2.038	-0.618	-0.781	-0.016	-0.380	-0.051	-1.103	-0.013	-1.466	-0.120	-1.072	0.531***	3.068
Female newar	0.374	0.385	0.024	0.026	0.000	0.001	-0.049	-0.805	0.008	0.777	-0.393***	-3.117	0.135	0.552
Intercept	96.897***	115.866	98.772***	109.475	-2.787***	-47.707	-2.625***	-45.181	0.428***	34.461	5.422***	38.761	1.927***	10.452
VDC fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Number of observations	203,880		183,542		256,347		256,347		256,292		315,221		315,299	

note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors are clustered by VDC.

(1) average education subtracted to ensure that the coefficient on female scarcity can be interpreted directly.

Table 4. Child outcome regressions

	School attendance		Years of schooling		Months of work	
Child and household characteristics	**coef**	**t**	**coef**	**t**	**coef**	**t**
Child age 7	0.096***	27.476	0.351***	42.188	na	.
Child age 8	0.140***	33.699	0.833***	60.758	na	
Child age 9	0.180***	36.689	1.312***	67.555	na	
Child age 10	0.186***	36.380	1.857***	66.642	-0.141***	-8.340
Child age 11	0.206***	36.695	2.483***	72.454	omitted category	
Child age 12	0.189***	35.983	2.977***	67.770	0.163***	8.939
Child age 13	0.176***	33.063	3.667***	66.920	0.312***	14.898
Child age 14	0.145***	27.453	4.265***	66.814	0.601***	20.540
Child age 15	0.070***	11.765	4.693***	57.045	1.011***	24.508
Female child	-0.086***	-21.693	-0.351***	-19.229	0.133***	4.905
# older male co-residing siblings	-0.009***	-7.596	-0.014**	-2.145	0.012	1.097
# older female co-residing siblings	0.006***	4.783	0.079***	11.030	-0.106***	-10.965
Log(household size)	-0.018***	-4.821	-0.185***	-8.478	0.139***	4.922
Number children/Household size	-0.145***	-19.910	-1.108***	-29.701	0.810***	12.657
Biological mother only	-0.078***	-13.708	-0.404***	-12.444	0.876***	13.113
Biological father only	-0.075***	-10.436	-0.359***	-9.064	0.632***	9.450
Marriage market variables						
Female scarcity	**-0.020***	-1.837	-0.056	-1.174	0.075	1.076
Female scarcity x male education (1)	**0.026*****	11.502	**0.080*****	7.760	**-0.093*****	-7.307
Female scarcity x female education (1)	**0.005****	2.015	**0.035*****	2.782	**0.021***	1.745
Education and age variables						
Male education	0.038***	22.102	-0.043***	-6.198	-0.095***	-8.650
Male education squared	-0.001***	-17.820	-0.001***	-2.841	0.006***	11.991
Female education	0.031***	16.101	-0.062***	-4.181	0.024**	2.342
Female education squared	-0.000***	-4.542	-0.006***	-8.784	0.001**	2.009
Male education x female education	-0.001***	-11.931	-0.006***	-10.672	0.004***	7.823
Male age	0.002	1.452	-0.025***	-5.294	0.016*	1.655
Male age squared	-0.000	-0.386	0.000	0.960	-0.000	-0.860
Female age	0.006***	5.046	0.027***	5.030	0.006	0.558
Female age squared	-0.000**	-2.323	-0.001***	-4.150	0.000	0.345
Male age x female age	-0.000	-0.241	0.000*	1.746	-0.000	-0.082
Male age x male education	-0.000***	-6.792	0.004***	30.312	-0.001***	-3.652
Female age x female education	-0.000***	-10.120	0.006***	17.095	-0.002***	-8.246
Language, religion, and ethnicity controls						
Male mother tongue Nepali	0.019	1.637	0.133***	2.651	-0.011	-0.157
Male hindu	0.015	1.386	-0.080	-1.606	-0.009	-0.087
Male brahmin	0.055***	3.341	0.537***	6.829	-0.547***	-4.960
Male chhetri	0.028**	2.137	0.240***	3.266	-0.342***	-3.053
Male newar	0.078***	5.804	0.451***	5.666	-0.316***	-3.069
Female mother tongue Nepali	0.006	0.610	-0.028	-0.652	-0.154*	-1.932
Female hindu	-0.020*	-1.818	0.037	0.749	0.004	0.035
Female brahmin	0.022	1.322	0.084	1.083	0.174	1.607
Female chhetri	0.038***	2.923	0.166**	2.299	0.062	0.562
Female newar	-0.013	-1.005	0.020	0.264	-0.034	-0.350
Intercept	0.602***	27.488	1.341***	14.175	-0.378*	-1.747
VDC fixed effects	Yes		Yes		Yes	
Number of observations	379,090		379,170		222,648	

note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors are clustered by VDC.

(1) average education subtracted to ensure that the coefficient on female scarcity can be interpreted directly.